**String Art: Axon Tracts in the Spinal Cord**

Use the descriptions in this document to trace the following:

Spinal reflex arcs

Corticospinal tracts

Dorsal column tracts

Spinothalamic tracts

Spinocerebellar tracts

Please note that descriptions are somewhat simplified.

**Spinal reflex arcs**

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| **Site** | **Neuron** | **Description** |
| **Hand** | 1 | Sensory axons\* originate in muscle spindle |
| Dorsal root ganglion | 1 | Cell bodies of sensory neurons |
| Cervical enlargement of spinal cord | 1/2 | Sensory axons synapse onto (lower) motor neurons in ventral horn |
| **Hand** | 2 | Motor axons terminate at neuromuscular junctions |

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| **Site** | **Neuron** | **Description** |
| **Foot** | 1 | Sensory axons\* originate in muscle spindle |
| Dorsal root ganglion | 1 | Cell bodies of sensory neurons |
| Lumbar enlargement of spinal cord | 1/2 | Sensory axons synapse onto (lower) motor neurons in ventral horn |
| **Foot** | 2 | Motor axons terminate at neuromuscular junctions |

\* Technically dendrites, but usually called axons.**Corticospinal tracts**

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| **Site** | **Neuron** | **Description** |
| Cerebral cortex | 1 | Cell bodies of upper motor neurons lie in **hand** region of primary motor cortex. Axons descend through internal capsule. |
| Mid-brain | 1 | Axons of corticospinal tract descend in base of cerebral peduncle |
| Pons | 1 | Axons of corticospinal tract descend in bundles within basal pons |
| Open medulla | 1 | Axons of corticospinal tract descend through the medullary pyramid |
| Lower medulla | 1 | Axons cross at the pyramidal decussation |
| Cervical enlargement of spinal cord | 1/2 | Axons of the lateral corticospinal tract synapse with lower motor neurons in ventral horn |
| **Hand** | 2 | Motor axons terminate at neuromuscular junctions |

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| **Site** | **Neuron** | **Description** |
| Cerebral cortex | 1 | Cell bodies of upper motor neurons lie in **foot** region of primary motor cortex. Axons descend through internal capsule. |
| Mid-brain | 1 | Axons of corticospinal tract descend in base of cerebral peduncle |
| Pons | 1 | Axons of corticospinal tract descend within basal pons |
| Open medulla | 1 | Axons of corticospinal tract descend through the medullary pyramid |
| Lower medulla | 1 | Axons crosses at the pyramidal decussation |
| Cervical enlargement of spinal cord | 1 | Axons descend in the lateral corticospinal tract (lateral fasciculus of spinal cord) |
| Thoracic spinal cord | 1 | Axons descend in the lateral corticospinal tract |
| Lumbar enlargement of spinal cord | 1/2 | Axons of the lateral corticospinal tract synapse with lower motor neurons in ventral horn |
| **Foot** | 2 | Motor axons terminate at neuromuscular junctions |

Note that all of the fibres to muscles in the upper and lower limbs cross at the pyramidal decussation. Fibres going to the axial muscles (about 15% of corticospinal fibres) remain uncrossed, travel in the anterior corticospinal tract and then supply motor neurons on both sides of the spinal cord.**Dorsal column tracts**

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| **Site** | **Neuron** | **Description** |
| **Hand** | 1 | Sensory axons\* originate in sense organs for fine touch (Meissner’s corpuscles, Pacinian corpuscles) or proprioception (muscle spindles) |
| Dorsal root ganglion | 1 | Cell bodies of 1o sensory neurons |
| Cervical enlargement of spinal cord | 1 | Axons enter via dorsal root then travel in dorsal column (cuneate fasciculus) |
| Lower (closed) medulla | 1/2 | Synapse with 2o sensory neurons in cuneate nucleus. Axons from cuneate nucleus cross over to medial lemniscus at the level of the upper medulla (decussation not shown on model). |
| Upper (open) medulla | 2 | Axons travel in the medial lemniscus |
| Pons | 2 | Axons travel in the medial lemniscus |
| Mid-brain | 2 | Axons travel in the medial lemniscus |
| Thalamus | 2/3 | Synapse with 3o neurons in thalamus (ventral posterior nucleus) |
| Cerebral cortex | 3 | Synapse in **hand** region of primary somatosensory cortex |

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| **Site** | **Neuron** | **Description** |
| **Foot** | 1 | Sensory axons\* originate in sense organs for fine touch (Meissner’s corpuscles, Pacinian corpuscles) or proprioception (muscle spindles) |
| Dorsal root ganglion | 1 | Cell body of 1o sensory neuron |
| Lumbar enlargement of spinal cord | 1 | Axons enter via dorsal root then ascend in dorsal column (gracile fasciculus) |
| Thoracic spinal cord | 1 | Axons continue to ascend in dorsal column (gracile fasciculus) |
| Cervical enlargement of spinal cord | 1 | Axons continue to ascend in dorsal column (gracile fasciculus) |
| Lower (closed) medulla | 1/2 | Synapse with 2o sensory neurons in gracile nucleus. Axons from gracile nucleus cross over to medial lemniscus at the level of the upper medulla (decussation not shown on model). |
| Upper (open) medulla | 2 | Axons travel in the medial lemniscus |
| Pons | 2 | Axons travel in the medial lemniscus |
| Mid-brain | 2 | Axons travel in the medial lemniscus |
| Thalamus | 2/3 | Synapse with 3o neurons in thalamus (ventral posterior nucleus) |
| Cerebral cortex | 3 | Synapse in **foot** region of primary somatosensory cortex |

\* Technically dendrites, but usually called axons.**Spinothalamic tracts**

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| **Site** | **Neuron** | **Description** |
| **Hand** | 1 | Sensory axons\* originate from free nerve endings |
| Dorsal root ganglion | 1 | Cell bodies of 1o sensory neurons |
| Cervical enlargement of spinal cord | 1/i/2 | Axons synapse with interneurons in substantia gelatinosa. Interneurons synapse with 2o neurons. Axons from 2o neurons cross over to contralateral spinothalamic tract |
| Lower medulla | 2 | Axons ascend in spinothalamic tract |
| Open medulla | 2 | Axons continue to ascend within spinal lemniscus |
| Pons | 2 | Axons continue to ascend within spinal lemniscus |
| Mid-brain | 2 | Axons continue to ascend within spinal lemniscus |
| Thalamus | 2/3 | Synapse with 3o neurons in thalamus |
| Cerebral cortex | 3 | Synapse in **hand** region of primary sensory cortex |

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| **Site** | **Neuron** | **Description** |
| **Foot** | 1 | Sensory axons\* originate from free nerve endings |
| Dorsal root ganglion | 1 | Cell bodies of 1o sensory neurons |
| Lumbar enlargement of spinal cord | 1/i/2 | Axons synapse with interneurons in substantia gelatinosa. Interneurons synapse with 2o neurons. Axons from 2o neurons cross over to contralateral spinothalamic tract |
| Thoracic spinal cord | 2 | Axons ascend in spinothalamic tract |
| Cervical enlargement of spinal cord | 2 | Axons continue to ascend in spinothalamic tract |
| Lower medulla | 2 | Axons continue to ascend in spinothalamic tract |
| Open medulla | 2 | Axons continue to ascend within spinal lemniscus |
| Pons | 2 | Axons continue to ascend within spinal lemniscus |
| Mid-brain | 2 | Axons continue to ascend within spinal lemniscus |
| Thalamus | 2/3 | Synapse with 3o neurons in thalamus |
| Cerebral cortex | 3 | Synapse in **foot** region of primary sensory cortex |

\* Technically dendrites, but usually called axons.

**Spinocerebellar tracts (dorsal)**

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| **Site** | **Neuron** | **Description** |
| **Hand** | 1 | Sensory axons\* originate in proprioceptive organs such as muscle spindle or golgi tendon organ |
| Dorsal root ganglion | 1 | Cell bodies of 1o sensory neurons |
| Cervical enlargement of spinal cord | 1 | Axons ascend in cuneate fasciculus |
| Lower (closed) medulla | 1 | Axons ascend in cuneate fasciculus |
| Upper (open) medulla | 1/2 | Axons synapse with 2o neurons in accessory cuneate nucleus. Axons from these 2o neurons pass through the inferior cerebellar peduncle |
| Cerebellum | 2 | Axons synapse in cerebellar cortex |

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| **Site** | **Neuron** | **Description** |
| **Foot** | 1 | Sensory axons\* originate in proprioceptive organs such as muscle spindle or golgi tendon organ |
| Dorsal root ganglion | 1 | Cell bodies of 1o sensory neurons |
| Lumbar enlargement of spinal cord | 1 | Axons ascend in gracile fasciculus to thoracic level |
| Thoracic spinal cord | 1/2 | Axons leave gracile fasciculus to synapse with 2o neurons in Clarke’s column/nucleus. Axons from these 2o neurons enter the dorsal spinocerebellar tract |
| Cervical enlargement of spinal cord | 2 | Axons ascend in dorsal spinocerebellar tract |
| Lower (closed) medulla | 2 | Axons ascend in dorsal spinocerebellar tract |
| Upper (open) medulla | 2 | Axons pass through the inferior cerebellar peduncle |
| Cerebellum | 2 | Axons synapse in cerebellar cortex |

\* Technically dendrites, but usually called axons.

Note that there are also ventral spinocerebellar tracts, which are a bit more complicated. They are part of a system that integrates descending motor signals with ascending proprioceptive signals.